**TPB R09 December 2011**

**SET -1**

1. a) What is meant by the term “Non-Newtonian”? What types of substance exhibit this behaviour?

b) Describe about the “cone-and-plate viscometer”.

1. a) Discuss about the equation of motion.

b) Define the terms ‘friction factor’ and ‘drag coefficient’.

1. a) Compare Fourier’s law of heat conduction with Newton’s law of viscosity.

b) Discuss the effect of T and P on thermal conductivity of gasses and liquids.

1. Derive the temperature distribution in a semi-infinite slab.
2. Write short notes on the following:
	1. Boundary layer theory.
	2. Film theory.
	3. Role of diffusion in bioprocessing.
3. Estimate the rate of absorption of CO2 into a water film flowing down a vertical wall 1m long at the rate of 0.05 kg/s per meter of width at 25ºC. The gas is pure CO2 at 1 std atm. The water is essentially CO2 – free initially. The solubility of CO2 in water at 25ºC, 1 std atm, is CAi =0,0336 kmol/m³, µ=8.9 x 10-4 kg/ms, DAB = 1.96 x 10-9 m2/s, solution density = 998 kg/m3, Γ = o.o5 kg/ms, L = 1m.
4. a) Write some applications of mass transfer in bioprocessing.

b) Explain the process of mass transfer by convection.

1. Discuss the following
	1. Oxygen uptake in cell cultures
	2. Antifoam agents

**SET -2**

1. a) What is Newtown’s law of viscosity? Explain

b) How does the viscosity vary with T and P for dilute gases and liquids?

1. Derive the equations for friction factor in packed columns.
2. a) Describe the analogy between heat and momentum transfer

b) Compare the temperature dependence of thermal conductivity for gases, liquids and solid.

1. Derive the temperature distribution in a semi – infinite and finite slab.
2. a) Compare Fick’s law of diffusion with Newton’s law of viscosity and Fourier’s thermal conductivity. To what extent are these three relations analogous?
3. Describe about boundary layer theory and penetration theory.
4. a) Explain the process of mass transfer by convection.

b) Write short notes on liquid – solid mass transfer.

1. Describe about the following.
	1. Oxygen balance method
	2. Oxygen transfer in fermentor

**SET -3**

1. a) How do you measure the viscosity using coaxial cylinder rotary viscometer?

b) Discuss about the rheological properties of fermentation broth.

1. Derive the equation for friction factor when the fluid is flowing in tubes.
2. A Plastic panel of area A=900 cm2 and thickness Y=0.6cm was found to conduct heat at a rate of 3.5 watts at steady state with temperatures of T0 = 25oC and T1=25oC on the two main surfaces. What is the thermal conductivity of plastic in cal/m sec K?
3. Derive the temperature distribution in a stirred tank Reactor when the flow is turbulent.
4. a) Discuss about boundary layer theory and film theory

b) What does the Corrsin equation describe?

1. a) Define mass transfer coefficient and derive the equations to calculate mass transfer coefficient

b) Discuss about penetration theory.

1. a) What are the various correlations for evaluating mass transfer coefficient?

b) Write short notes on liquid- liquid mass transfer.

1. a) What are the factors affecting cellular oxygen demand? Explain

b) Discuss about oxygen uptake in cell cultures.

**SET -4**

1. a) Discuss about impeller viscometer.

b) What is meant by the term “Non-Newtonian”? What types of substances exhibit this behaviour?

1. a) Give the physical significance of the three derivatives in which T is the local fluid temperature.

b) What is continuity equation? Explain.

1. A plastic panel of area A=929 cm2 and thickness Y=0.64 cm was found to conduct heat at a rate of 3 watts at steady state with temperatures of T0 = 24oC and T1 = 26o C on the two main surfaces. What is the thermal conductivity of the plastic in cal/m sec K?
2. Derive the temperature distribution for a Stirred Tank Reactor and discuss the relationship between cell concentration & stirred conditions.
3. a) What is diffusion? What factors may cause diffusion to occur?

b) Discuss the analogy between mass, heat and momentum transfer.

1. a) Discuss about penetration theory.

b) In an aerobic fermentation process, the typical average bubble diameter is 3 mm, with an average raise velocity of 18 cm/s. If the diffusivity coefficient is 8 x 10-10 m2/s, find the mass transfer coefficient on the basis of penetration theory.

1. a) Write some applications of mass transfer in bioprocessing.

b) Write short notes on gas-liquid mass transfer.

1. a) Discuss about the measurements of kLa using dynamic method.

b) What are the factors affecting cellular oxygen demand? Explain.